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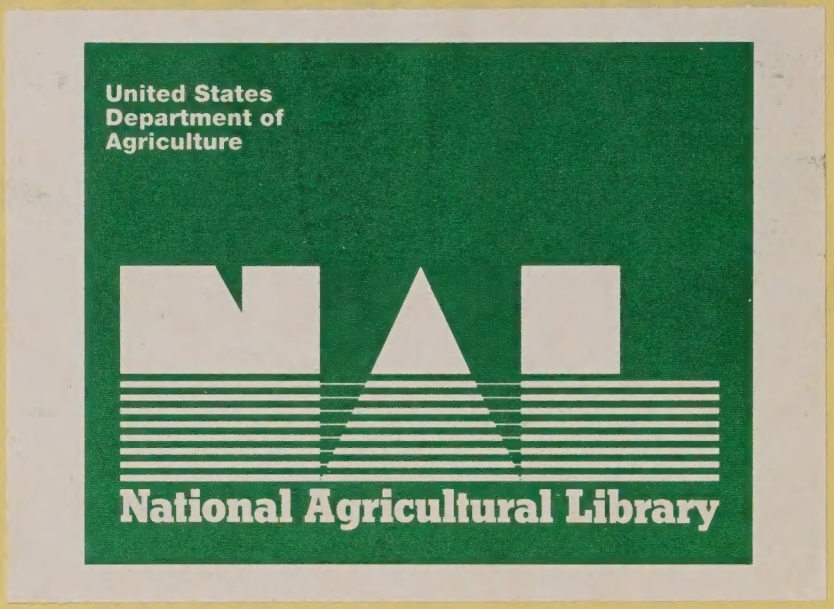
Pesticide Assessment of Field Corn and Soybeans: Corn Belt States

National Agricultural Pesticide Impact
Assessment Program



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ABSTRACT

This report summarizes the pesticide assessment for field corn and soybeans in the Corn Belt. Without insecticides, corn rootworm larvae and other soil insects would cause substantial corn yield losses, and Mexican bean beetles would reduce soybean yields. The loss of seed treatments would result in yield losses to both corn and soybeans. Among the herbicides, the loss of triazines would cause the greatest corn yield losses, while either dinitroanilines, acetanilides, or bentazon would cause the greatest soybean yield losses. This report includes pest rankings, estimates of acreages treated with pesticides or other pest management practices, and estimates of pest losses with and without pesticide use, for insects, diseases, nematodes, and weeds.

Keywords: Corn, soybeans, pest losses, pest control, pesticide use, pesticide regulations.

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INTRODUCTION

This report summarizes the field corn and soybean assessment for the Corn Belt States of Illinois, Indiana, Iowa, Missouri, and Ohio. Included are rankings of important pests in order of economic importance, pesticide use, estimates of acreages where major pesticides and other pest management practices are used, estimates of yield losses caused by pests with current practices, and estimates of losses when no pesticides are used. Estimates of losses are averaged for each State, but losses incurred by some producers will be significantly greater than the State or regional averages.

Land planted to corn and soybeans constituted 82 percent of the land used for crops (excluding pasture or idle land) in the Corn Belt States in 1978; corn accounted for 45 percent, while soybeans accounted for 37 percent. These States accounted for 46 percent of the U.S. acreage planted to corn and 47 percent of the U.S. acreage planted to soybeans. The average area planted to corn during 1976-80 was 11,580,000 acres for Illinois, 6,400,000 for Indiana, 13,820,000 for Iowa, 2,740,000 for Missouri, and 3,974,000 for Ohio. The average area planted to soybeans during this same period was 8,970,000 acres for Illinois, 4,066,000 for Indiana, 7,534,000 for Iowa, 5,246,000 for Missouri, and 3,596,000 for Ohio. The Corn Belt region produced approximately 55 percent of both corn and soybeans in the U.S. from 1976 to 1980.

The pesticide assessment by commodity program, a cooperative effort of the State universities and the U.S. Department of Agriculture (USDA) under the National Agricultural Pesticide Impact Assessment Program (NAPIAP), is employed because required information does not exist or has not been assembled in a readily usable format. The program improves response to Environmental Protection Agency (EPA) regulatory activity; provides information for Extension Service (ES) educational delivery systems; promotes information transfer among disciplines, regions, and States; identifies research needs and data gaps in pest control technology; and identifies emerging pest problems.

The procedure draws upon the knowledge of experts in entomology, nematology, plant pathology, weed science, and related sciences. These experts, in consultation with colleagues both within and among disciplines, were asked to draw upon research and demonstration plots, field experience, and pest control surveys to develop the information base. Concern is always expressed over compiling information not based completely on replicated field trials or systematically

planned use surveys. However, information based on such trials has not been, and likely will not be, forthcoming for most crops and pest problems. Thus, the combined experiences of the scientists involved formed the bases for this report.

This regional pesticide assessment for field corn and soybeans represents an effort to estimate, in an orderly manner, yield losses and the effects of pesticide regulatory actions within the context of overall pest control practices. NAPIAP believes that this report and the underlying information base are useful for evaluating the effects of pesticide regulatory actions and the importance of pests. NAPIAP also believes that this study will contribute to future studies of this nature and indicate important areas for future research.

This report does not evaluate economic factors such as costs, crop prices, or pesticide price changes resulting from regulatory actions. It does not evaluate how pesticide price changes might influence pesticide use and crop losses. A future report will examine the effects of potential regulatory actions on costs and crop prices.

PROCEDURE FOR DATA COLLECTION

The NAPIAP State liaison representative for each State identified the participating specialists. The Agricultural Research Service (ARS), USDA, and the Economic Research Service (ERS), USDA, provided facilitators to guide the participants through the process.

The procedure followed several steps. All State specialists identified homogeneous production regions for corn and soybeans (equally subjected to pest problems, yield losses, and control practices). The specialists then estimated the percentage of field corn or soybeans planted under conventional, reduced, and no-till systems. Information was also included if irrigation significantly affected pest problems.

This report presents pest and pesticide information on insects, diseases, nematodes, and weeds. For each discipline, the 15 most important pest species were ranked for each production region, based on the acreage requiring treatment, the yield and quality losses, and the probability of recurrence. Pesticide treatments were identified by active ingredient, timing of application, and percentage of planted acres treated in each production region. Target pests for treatment were identified, and estimates of the proportion of planted acres treated for each were made. Also identified were nonchemical pest management practices, the target pests, and the percentage of planted acres treated.

Registered insecticides and fungicides were identified for each target pest and ranked by efficacy of yield. Pesticides with yield effects which were not significantly different received the same ranking.

Yield and percentage of planted acres were estimated where the pests in question caused no, low, medium, and high losses under current pest control practices used by growers. Yield and/or percentage of planted acreage were revised for each impact level by assuming that the most effective pesticide(s) is no longer available for use and that other pesticides and management practices can be used. This procedure continued by removing the second, then the third, and so forth, most effective pesticide(s) in succession while revising the yield and

acreage estimates. Finally, estimates were made assuming no chemical pesticide control was available for the pest in question. Separate estimates were made for tillage systems or production regions where impacts differed.

Herbicides were not ranked by efficacy. Estimates of the effect on yield of removing important herbicides and groups of herbicides such as triazines, thiocarbamates, or phenoxys were made. First, yield estimates were made for no, low, medium, and high losses resulting from all weeds and the percentage of planted acreage for each impact level for the current pattern of weed control practices. Then, a specific herbicide or group of herbicides was assumed unavailable for use. Resulting new weed problems and alternative control practices were identified, and estimates of yield and percentage of planted acres for each new impact level were made. Next, the first herbicide or group of herbicides was assumed available for use again, while a second herbicide or group of herbicides was assumed unavailable. Then the procedure was repeated. This process continued until the effects of removing each major herbicide and group were examined. Finally, changes in cultivation practices were identified and yield effects were estimated where herbicides were unavailable.

FIELD CORN

Tillage Systems

An estimated 43 percent of the acres planted to corn in the Corn Belt States were under conventional tillage, 54 percent under reduced tillage, and 3 percent under no-till. Illinois, Indiana, and Missouri had identical distributions with 50 percent under conventional, 48 percent under reduced, and 2 percent under no-till (table 1). Iowa had more reduced tillage, while Ohio had more conventional tillage and no-till.

Insects, Insecticides, and Losses

The Corn Belt States (except Indiana where determinations were not available) unanimously designated corn rootworm larvae as the most important corn pest (table 2), followed closely by European corn borers and cutworms. Thereafter, the ranking of insects met with less uniformity among States. Stalk borers and wireworms ranked next in importance, followed by corn rootworm adults, armyworms, aphids, leafhoppers, white grubs, the seedfeeding complex, fall armyworms, and grasshoppers. The remaining pests were considered less important economically; in the order designated, they were corn earworms, sod webworms, billbugs, slugs, southwestern corn borers, flea beetles, and chinch bugs.

The greatest number (14 percent) of planted acres in the Corn Belt States were treated with chlorpyrifos, applied principally for cutworms and corn rootworms (table 3). Fonofos and terbufos were the next most common insecticides, each used on 12 percent of the planted acres, primarily for corn rootworm larvae. A small percentage of acres was treated with fonofos for European corn borer and wireworm control, and a small percentage was treated with terbufos for wireworm control. Carbofuran, applied to 6 percent of the planted acres, was directed primarily toward European corn borer control. Roughly a third of the total carbofuran treated acres were to control corn rootworm larvae and a small number of acres to control wireworms.

Table 1. Corn acreage under major tillage systems in the Corn Belt States 1/

Tillage systems	Percentage of planted acres					
	IL	IN	IA	MO	OH	Region 2/
	Percent					
Conventional 3/	50	50	26	50	64	43
Reduced 4/	48	48	70	48	27	54
No-till 5/	2	2	4	2	9	3

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ State estimates were weighted by planted acres and averaged to obtain the regional estimates.
3/ Moldboard plowing, two passes with disc or field cultivator before planting, one or more cultivations after crop emergence.
4/ Disc-plowing: disc stubble one or two times before planting, one cultivation after crop emergence; chisel-plowing: chisel plow, one cultivation after crop emergence; or rotary-tillage: disc stubble, roto-till and plant in one pass, one cultivation after crop emergence.
5/ No tillage operations before, during, or after planting.

Table 2. Ranking of corn insect pests in the Corn Belt States 1/

Insects	Rank 2/					
	IL	IN	IA	MO	OH	Region
Corn rootworms (larvae)	1	1	1	1	1	1
European corn borers	2	2	2	2	4	2
Cutworms	2	3	3	1	2	3
Stalk borers	5	4	4	10	5	4
Wireworms	4	6	5	4	8	5
Corn rootworms (adult)	3	3	7	NR	9	6
Armyworms	7	4	6	11	3	7
Aphids and leaf hoppers	5	5	7	13	12	8
White grubs	8	6	7	8	10	9
Seedfeeding complex	6	NR	7	9	NR	10
Fall armyworms	8	7	7	NR	6	11
Grasshoppers	6	NR	7	NR	NR	12
Corn earworms	NR	NR	7	3	NR	13
Sod webworms	NR	NR	7	NR	11	14
Billbugs	NR	NR	7	10	NR	15
Slugs	NR	7	NR	NR	7	16
Southwestern corn borers	NR	NR	NR	5	NR	17
Flea beetles	NR	NR	NR	6	NR	18
Chinch bugs	NR	NR	NR	7	NR	19

NR = Not reported.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ 1 = Most serious, 2 = second-most serious, etc,. Regional rankings were weighted averages of State-level rankings. State-level rankings were uniformly standardized so each would have the same mean and variance. The standardized variables were weighted by planted acres to construct the regional ordering.

Table 3. Corn insecticide use by timing and target pest in the Corn Belt States 1/

Active ingredients	Timing 2/	Target pest	Percentage of planted acres 3/				
			IL	IA	MO	OH	Region 4/
			Percent				
Carbaryl	8,10	Cutworms	1	-	-	-	<1
	8,10	Fleabeetles	-	-	1	-	<1
	8,10	Corn rootworm adults	1	-	-	-	<1
	8,10	Other	-	<1	<1	-	<1
		Total	2	<1	2	-	1
Carbofuran	8,10	European corn borers	1	4	<1	13	4
	3,7	Corn rootworms	1	3	2	-	2
	2	Wireworms	-	-	1	-	<1
		Total	2	7	3	13	6
Chlorpyrifos	3	Corn rootworms	4	9	-	4	6
	1,3,8	Cutworms	7	5	31	-	7
	2,8	Other	-	1	<1	-	<1
		Total	11	15	32	4	14
Diazinon	ST	Seedfeeding complex	-	-	5	-	<1
Ethoprop	3	Corn rootworms	1	1	<1	-	<1
	3	Cutworms	1	-	<1	-	<1
		Total	2	1	1	-	1
Fonofos	10	European corn borers	-	2	-	-	<1
	3	Corn rootworms	12	11	-	16	7
	3	Cutworms	1	-	<1	-	<1
		Total	13	12	<1	16	12
Isofenfos	3	Corn rootworms	4	2	-	1	3
Lindane	ST	Seedfeeding complex	-	-	2	-	<1
	3	Wireworms	-	-	-	3	<1
		Total	-	-	2	3	<1
Methyl parathion (encapsulated)	10	European corn borers	1	<1	-	-	<1
Phorate	3	Corn rootworms	2	4	<1	1	3
	10	European corn borers	-	<1	-	-	<1
		Total	2	5	<1	1	3
Terbufos	3,7	Corn rootworms	15	11	3	16	12
	2	Wireworms	-	<1	1	-	<1
		Total	15	11	4	16	12
Toxaphene	1,8	Armyworms, cutworms, stalkborers	-	-	2	1	<1

- = Insignificant acreage.

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.

2/ Timing of application, where:
ST = Seed treatment.
1 = Preplant broadcast with or without incorporation.
2 = In furrow at planting.
3 = At planting as a band.
7 = Postemergence layby, with or without incorporation.
8 = Postemergence foliar or over row.
10 = Postemergence aerial.

3/ Indiana did not provide estimates of acres treated.

4/ State estimates were weighted by planted acres and averaged to obtain regional estimates.

Phorate and isofenfos each were applied to 3 percent of the planted acres for corn rootworm larvae, although some acres were treated with phorate for corn borers. The remaining insecticides, consisting of carbaryl, diazinon, ethoprop, lindane, methyl parathion, and toxaphene, were each used on less than 1 percent of the planted acres. Target pests included those already mentioned, as well as seed feeders and stalk borers.

Various nonchemical insect controls were identified (table 4). Resistant and tolerant hybrids were identified, primarily for European corn borers. Weed control was an effective measure of avoiding stalk borer infestations, and crop rotation was a major method of avoiding corn rootworm infestations. Illinois and Missouri identified scouting for various species.

Removal of insecticides from the market place may inflict serious yield losses on those acres already receiving frequent infestations, especially those infested with corn rootworm larvae, cutworms, and European corn borers. Corn rootworm larvae caused 1.4-percent yield losses in the region (table 5). Without pesticides, these losses could increase to 9.7 percent with the current rotations. If more corn acreage were rotated with soybeans, losses could be much less, with one State predicting a yield increase. European corn borers caused 2.4-percent yield losses in the region; these losses could increase to 5.6 percent

Table 4. Nonpesticide corn insect management in the Corn Belt States 1/

Insects	Insect management practice	Percentage of planted acres 2/			
		IL	IA	MO	OH
		Percent			
All insects	Scouting 3/	-	-	1	-
Black cutworms	do.	40	-	-	-
Corn leaf aphids	do.	10	-	-	-
Corn rootworm beetles	do.	15	-	-	-
Corn rootworm larvae	Rotation	-	17	-	50
European corn borers	Resistant hybrids	10	15	-	-
	Scouting	25	2	-	1
	Tolerant hybrids	-	80	-	-
Southwestern corn borers	Early planting	-	-	10	-
Stalk borers	Weed control	99	-	-	-

- = Insignificant acreage.

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.

2/ Indiana provided no estimates.

3/ Scouting is a pest detection practice which may lead to the use of pesticide or nonpesticide pest management practices.

Table 5. Average percentage corn insect yield losses in the Corn Belt States 1/

Insects and insect control practices	Average percentage yield loss 2/ 3/				
	IL	IA	MO	OH	Region 4/
	Percent				
Armyworms:					
Current controls	-	-	0.3	2.5	0.3
No pesticide controls	-	-	2.5	4.8	.8
Corn rootworm larvae:					
Current controls	0.4	2.3	1.4	1.6	1.4
No pesticide controls (current rotation)	3.3	13.0	3.2	21.0	9.7
No pesticide controls (rotate with soybeans)	1.6	-	1.5	5/(1.6)	.5
Cutworms:					
Current controls	.6	1.5	7.6	.2	1.6
No pesticide controls	2.3	4.8	33.1	.6	5.8
European corn borers:					
Current controls	.7	5.0	-	-	2.4
No pesticide controls	.7	12.4	-	-	5.6
Southwestern corn borers:					
Current controls	-	-	.2	-	<.1
No pesticide controls	-	-	.2	-	<.1
Stalk borers:					
Current controls	-	1.6	-	-	.7
No pesticide controls	-	4.7	-	-	2.0
Wireworms:					
Current controls	.1	-	8.6	-	.8
No pesticide controls	.1	-	24.5	-	2.1
Seedfeeding complex:					
Current controls	-	-	5.0	-	.4
No pesticide controls	-	-	20.0	-	1.7

- = Insignificant yield loss.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ These estimates were averaged over the entire planted corn acreage in each State. Estimates are losses from a yield where the pest causes no perceptible damage.
3/ Indiana did not estimate yield losses.
4/ State estimates were weighted by planted acres and averaged to obtain regional estimates.
5/ Ohio predicted that yield would increase if rotation were used.

without pesticides. The region's losses from cutworms were 1.6 percent, but could increase to 5.8 percent without pesticides. Stalk borers and wireworms each caused less than 1-percent losses, but these losses could increase to approximately 2 percent without pesticides.

Diseases, Fungicides, Nematicides, and Losses

Stalk rots, northern corn leaf blight, ear and kernel rots, southern corn leaf blight, and nematodes were the five most economically important diseases in the Corn Belt (table 6). Stalk rots ranked the highest in all five States. The only other diseases identified by all States were ear and kernel rots, seed rots, and seedling blights.

All of the corn seed planted in the Corn Belt was treated with a fungicide to control seed rots and seedling blights (table 7). Of the total regional acreage, 95 percent was treated with captan, 3 percent with thiram, and 1 percent each with carboxin or maneb. There were also limited nematicide treatments in Indiana and Iowa. Regional insecticide use included 3 percent of the acreage treated with carbofuran and 1 percent with terbufos.

A wide variety of nonchemical disease control practices was reported. Resistant varieties were often identified for disease management, such as Anthracnose leaf blight, common rust, common smut, ear and kernel rots, eyespot, leaf blight, leaf spot, northern corn leaf blight, southern corn leaf blight, stalk rots, and Stewart's wilt (table 8). The practices identified for each pest and the acreage of each practice varied widely among States.

Seed rots and seedling blights caused an estimated 1.6-percent yield loss across the Corn Belt (table 9). If chemical seed treatments were no longer available these losses may increase to 5.9 percent. Nematodes caused 1.7-percent losses in the region (based on the estimates from Indiana and Iowa where nematicide treatments were identified); without chemical control, these losses may increase to 2.4 percent.

Weeds, Herbicides, and Losses

Giant foxtail, velvetleaf, cocklebur, redroot pigweed, and Pennsylvania smartweed ranked as the five most economically important corn weed pests in the Corn Belt (table 10). Giant foxtail ranked the highest in all five States, and was the only weed pest to be identified by all five States. Velvetleaf, cocklebur, redroot pigweed, Pennsylvania smartweed, fall panicum, Johnsongrass, yellow nutsedge, and common ragweed were identified by four States.

The five herbicides most widely used in the region included atrazine on 57 percent of the acreage, alachlor on 43 percent, cyanazine on 24 percent, butylate on 20 percent, and metolachlor on 20 percent, applied singly and in tank mixes (table 11). Major mixes included atrazine plus alachlor, butylate, cyanazine, or metolachlor; cyanazine was often mixed with alachlor, metolachlor, or butylate. (Paraquat, EPTC, and propachlor are applied to relatively little acreage.)

The postemergence herbicides of 2,4-D and dicamba were applied individually to 7 percent and 6 percent of the acreage, respectively, with a dicamba plus 2,4-D mix applied to an additional 6 percent. These two postemergence herbicides

Table 6. Ranking of corn diseases and nematodes in the Corn Belt States 1/

Diseases and nematodes	Rank 2/					
	IL	IN	IA	MO	OH	Region
Stalk rots	1	1	1	1	1	1
Northern corn leaf blight	4	2	5	NR	2	2
Ear and kernel rots	7	2	3	2	6	3
Southern corn leaf blight	2	2	NR	NR	2	4
Nematodes	4	3/4	4/4	NR	10	5
Storage molds	5	NR	4	3	9	6
Seed rots and seedling blights	7	4	4	4	5	7
Leaf spot (not H. Carbonum)	NR	NR	2	6	NR	8
Stewart's wilt	3	NR	NR	5	2	9
Helminthosporium leaf spot	6	3	6	6	NR	10
Viruses	6	3	NR	NR	7	11
Anthracnose leaf blight	NR	3	NR	NR	3	12
Common smut	7	NR	7	NR	NR	13
Eyespot	NR	NR	NR	NR	4	14
Common corn rust	NR	NR	8	NR	8	15
MCDV & MDMV	NR	NR	NR	7	NR	16
Crazy top	NR	NR	NR	8	NR	17

NR = Not reported.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ 1 = Most serious, 2 = second-most serious, etc. Regional rankings were weighted averages of State-level rankings. State-level rankings were uniformly standardized so each would have the same mean and variance. The standardized variables were weighted by planted acres to construct the regional ordering.
3/ In Indiana, nematode species ranked as follows: 1 = lesion, 2 = needle, and 3 = lance.
4/ In Iowa, nematode species ranked as follows: 1 = lesion, 2 = dagger, 3 = lance, 4 = needle, 5 = spiral, 6 = stunt, 7 = stubby root, and 8 = pin.

Table 7. Corn fungicide and nematicide use in the Corn Belt States 1/

Active ingredients	Timing 2/	Target pest	Percentage of planted acres					
			IL	IN	IA	MO	OH	Region 3/
			Percent					
Captan	ST	Seed rots and seedling blights	94	85	99	100	100	95
Carboxin	ST	do.	3	-	-	-	-	1
Maneb	ST	do.	-	5	-	-	-	1
Thiram	ST	do.	4	10	1	-	-	3
Carbofuran	3	Nematodes	-	9	4	-	-	3
Terbufos	3	do.	-	4	2	-	-	1

- = Insignificant acreage.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ Timing of application, where: ST = Seed treatments (including planter box treatments), 3 = banded, at planting.
3/ State estimates were weighted by planted acres and averaged to obtain regional estimates.

Table 8. Nonpesticide corn disease and nematode management in the Corn Belt States 1/

Diseases and nematodes	Disease/nematode management practice	Percentage of planted acres				
		IL	IN	IA	MO	OH
		Percent				
Anthracnose leaf blight	Resistant varieties	-	90	-	-	79
	Rotation	-	13	-	-	79
Anthracnose stalk rot	Plowing	-	3	-	-	55
Common rust	Resistant varieties	-	-	100	-	20
Common smut	do.	-	90	100	-	-
Ear rots	Early harvest	-	-	-	-	22
	Early plowing	-	-	-	-	51
Ear and kernel rots	Resistant varieties	1	90	-	100	-
Eyespot	Plowing	-	-	-	-	78
	Resistant varieties	-	-	-	-	78
Leaf blight	do.	-	-	-	100	-
	Scouting 2/	-	-	80	-	-
Leaf spot	Resistant varieties	-	90	10	-	-
MDMV	Johnsongrass control	10	-	-	-	-
Nematodes	Rotation	2	80	-	-	-
Northern corn leaf blight	Resistant varieties	50	90	80	-	70
	Rotation	5	90	-	-	70
Seed rots and seedling blights	Certified seed	98	-	-	-	-
	Optimal planting time	98	-	-	-	-
Southern corn leaf blight	Resistant varieties	50	90	-	-	-
	Rotation	5	90	-	-	-
Stalk rots	Resistant varieties	90	90	50	100	64
	Rotation	-	90	-	-	64
Stewart's wilt	Resistant varieties	40	-	-	-	40
Storage molds	Drying grain	-	-	-	100	40
Other 3/	Insect control	5	-	-	-	-
	Rotation	5	-	-	-	-
	Scouting	50	-	-	-	-

- = Insignificant acreage.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ Scouting is a pest detection practice which may lead to the use of pesticide or other nonpesticide pest management practices.
3/ All diseases except seed rots, seedling blights, nematodes, ear and kernel rots, and storage molds.

Table 9. Average percentage corn yield losses from diseases and nematodes controlled with pesticides in the Corn Belt States 1/

Diseases, nematodes and control pesticides	Average percentage yield loss 2/					
	IL	IN	IA	MO	OH	Region 3/
			Percent			
Nematodes:						
Current controls	-	1.1	4.2	-	-	1.7
No pesticide controls	-	2.3	5.5	-	-	2.4
Seed rots and seedling blights:						
Current controls	<0.1	.8	1.3	0.4	9.5	1.6
No pesticide controls	.9	2.7	5.2	1.5	31.0	5.9

- = Insignificant yield loss.

1/ Corn and Soyban Commodity Assessment, NAPIAP, USDA.

2/ These estimates were averaged over the entire planted acres in each State. Estimates are losses from a yield where the pest causes no perceptible loss.

3/ State estimates were weighted by planted acres and averaged to obtain regional estimates.

were generally applied in sequence with alachlor, butylate, or melotachlor and sometimes with atrazine, EPTC, or paraquat.

Important nonpesticide weed management practices included cultivating, rotating crops, rotary hoeing, and professional scouting (table 12). The practices used and the acreage on which they were used varied widely among States.

Weeds caused a loss of approximately 4 percent to corn in the Corn Belt States (table 13). If atrazine were no longer available for use, damages would increase to 5.5 percent. If no triazines were available, damages would increase to approximately 12 percent. Losses would increase to about 9 percent if acetanilides were no longer available and to about 7 percent if thiocarbamates were no longer available. If either of the postemergence herbicides of 2,4-D or dicamba were no longer available, losses would increase to about 6 percent and 5 percent, respectively. The changes in crop yield losses would not be as significant if cyanazine, glyphosate, or paraquat were no longer available. Substitutes existed for cyanazine, while neither paraquat nor glyphosate were used on large acreages. If no herbicides were available, losses would be much greater, and would increase to about 47 percent with current cultivation and to 23 percent with extra cultivation.

Table 10. Ranking of corn weed pests in the Corn Belt States 1/

Weeds	Rank 2/					
	IL	IN	IA	MO	OH	Region
Giant foxtail	1	1	1	1	1	1
Velvetleaf	2	4	2	2	NR	2
Cocklebur	2	3	5	4	NR	3
Redroot pigweed	3	7	3	NR	3	4
Pennsylvania smartweed	3	NR	4	6	2	5
Yellow foxtail	6	NR	1	NR	3	6
Lambsquarters	5	NR	3	NR	3	7
Annual morningglory	2	4	NR	2	NR	8
Fall panicum	4	2	NR	5	3	9
Canada thistle	NR	7	6	NR	2	10
Quackgrass	7	NR	6	NR	3	11
Johnsongrass	7	2	NR	3	3	12
Yellow nutsedge	5	NR	9	5	3	13
Shattercane	7	5	8	3	NR	14
Hemp dogbane	NR	6	6	5	NR	15
Jimsonweed	3	7	NR	NR	NR	16
Common ragweed	5	NR	10	6	4	17
Green foxtail	NR	NR	NR	1	1	18
Climbing milkweed	NR	5	NR	2	3	19
Wooly cupgrass	NR	NR	7	NR	NR	20
Giant ragweed	NR	6	NR	NR	3	21
Hedge bindweed	NR	4	NR	NR	NR	22
Common milkweed	NR	NR	9	5	NR	23
Sunflower	NR	NR	9	5	NR	23
Black nightshade	NR	NR	9	NR	NR	25
Crabgrass	NR	NR	NR	NR	3	26
Horsenettle	NR	NR	NR	5	NR	27
Barnyardgrass	NR	NR	NR	NR	4	28
Wild cumcumber	NR	NR	NR	NR	4	28
Bur cucumber	NR	8	NR	NR	NR	30
Water hemp	NR	NR	NR	6	NR	31
Swamp smartweed	NR	NR	NR	6	NR	31

NR = Not reported.

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.

2/ 1 = Most serious, 2 = second-most serious, etc. Regional rankings were weighted averages of State-level rankings. State-level rankings were uniformly standardized so each would have the same mean and variance. The standardized variables were weighted by planted acres to construct the regional ordering.

Table 11. Corn herbicide use in the Corn Belt States 1/

Active ingredients	Percentage of planted acres					
	IL	IN	IA	MO	OH	Region 2/
	Percent					
Alachlor	10	12	21	1	6	13
Atrazine	9	5	6	9	4	7
Butylate + safener	5	-	9	5	1	5
Cyanazine	3	-	3	6	1	3
Dicamba	7	10	6	-	3	6
EPTC + safener	-	-	1	5	1	<1
Metolachlor	6	3	9	1	2	6
Propachlor	-	-	4	-	-	1
2,4-D	9	7	7	3	5	7
Atrazine + alachlor	16	42	14	11	25	20
Atrazine + butylate	18	10	5	5	10	10
Atrazine + cyanazine	3	-	4	-	4	3
Atrazine + metolachlor	16	5	6	11	19	11
Atrazine + other	-	5	-	3	-	1
Atrazine + alachlor + cyanazine	-	-	2	4	-	1
Atrazine + butylate + cyanazine	3	2	2	-	-	2
Atrazine + metolachlor + cyanazine	-	3	-	-	-	<1
Cyanazine + alachlor	2	-	15	3	4	7
Cyanazine + butylate	-	-	7	1	3	3
Cyanazine + EPTC	-	-	-	1	-	<1
Cyanazine + metolachlor	2	-	6	2	4	3
Dicamba + 2,4-D	4	-	11	5	10	6
Paraquat + atrazine + alachlor	-	2	1	13	1	2
Paraquat + other	-	<1	-	-	5	<1

- = Insignificant acreage.

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.

2/ State estimates were weighted by planted acres and averaged to obtain regional estimates.

Table 12. Nonpesticide corn weed management in the Corn Belt States 1/

Weed management practices	Percentage of planted acres				
	IL	IN	IA	MO	OH
	Percent				
Cultivation	70	NR	97	NR	NR
Rotation	75	90	70	NR	4
Rotary hoe	30	NR	45	NR	NR
Professional scouting 2/	30	NR	5	NR	4

NR = Not reported.
1/ Corn and Soybean Commodity Assessmnt, NAPIAP, USDA.
2/ Scouting is a pest detection practice which may lead to the use of pesticide or nonpesticide pest management practices.

Table 13. Average percentage corn weed yield losses in the Corn Belt States 1/

Weed control practices	Average percentage yield loss 2/					
	IL	IN	IA	MO	OH	Region 3/
	Percent					
Current controls 4/	4.7	4.7	3.6	7.8	1.7	4.2
Remove: 5/						
Atrazine	8.5	4.7	3.6	7.8	3.3	5.5
Cyanazine	5.6	4.7	3.6	7.8	2.8	4.2
Dicamba	6.2	7.3	3.7	7.8	2.3	5.2
Glyphosate	4.7	4.7	3.6	7.8	2.0	4.2
Paraquat	4.7	4.7	3.6	7.8	2.0	4.2
2,4-D	8.0	8.3	3.7	11.1	2.2	6.1
Acetanilides	13.3	9.3	6.0	8.3	3.2	8.6
Thiocarbamates	11.8	7.6	4.1	8.3	2.3	7.1
Triazines	14.4	23.2	6.4	12.4	6.8	12.1
No chemical controls:						
With current cultivation	52.5	52.2	40.4	40.5	40.9	47.1
With extra cultivation	13.0	33.6	30.9	21.5	5.0	22.6

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ These estimates are average yield losses over the entire planted acreage in the State from a maximum where weeds cause no loss. Other problems and farm management practices were held constant.
3/ State estimates were weighted by planted acres and averaged to obtain regional estimates.
4/ These estimates assume the current pattern of weed control practices in each State.
5/ These estimates assume that only the specific herbicide or herbicide group is no longer available for use. Other herbicides or control practices were substituted, and all other pest problems and farm management practices were held constant.

SOYBEANS

Tillage Systems

An estimated 47 percent of the soybean acreage in the Corn Belt States was under conventional tillage, 49 percent under reduced tillage, and 4 percent under no-till planting (table 14). Illinois, Indiana, and Ohio have much higher estimates of conventional tillage than do Iowa or Missouri, which had higher estimates of reduced tillage.

Insects, Insecticides, and Losses

The ranking of soybean pests among the Corn Belt States reflects information from Indiana, Missouri, and Ohio. Iowa and Illinois did not indicate difficulties from soybean insects, and available time did not permit Missouri to provide elaborate data. Mexican bean beetles and bean leaf beetles represented the most frequently cited insects in the region (table 15). Missouri indicated that corn earworms were that State's only other insect of soybeans, but the acreage involved was so small that earworms actually ranked last in regional importance. Japanese beetles and seed corn maggots were the third and fourth pests of economic importance. Grasshoppers, green cloverworms, spider mites, leafhoppers, cutworms, and wireworms were equal and relatively incidental in impact.

Carbaryl was used on 2 percent of the planted acres in the region to control Mexican bean beetles (table 16). None of the other insecticides were used on more than 1 percent of the planted acres.

Table 14. Soybean acreage under major tillage systems in the Corn Belt States 1/

Tillage systems	Percentage of planted acres					
	IL	IN	IA	MO	OH	Region 2/
	Percent					
Conventional 3/	60	78	27	15	70	47
Reduced 4/	36	17	71	80	28	49
No-till 5/	4	5	2	5	2	4

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ State estimates were weighted by planted acres and averaged to obtain the regional estimates.
3/ Moldboard plowing, two passes with disc or field cultivator before planting, one or more cultivations after crop emergence.
4/ Disc-plowing: disc stubble one or two times before planting, one cultivation after crop emergence; chisel-plowing: chisel plow, one cultivation after crop emergence; or rotary-tillage: disc stubble, roto-till and plant in one pass, one cultivation after crop emergence.
5/ No tillage operations before, during, or after planting.

Ohio was the only State that claimed noncultural control practices in the form of scouting (table 17). Scouting for Mexican bean beetles represented 50 percent of Ohio's acreage. Mexican bean beetles were the only pests identified that would markedly increase soybean yield losses without chemical control. Losses from this pest would increase from less than 0.1 percent with pesticides to 1.1 percent without pesticides (table 18). None of the other pests would cause noticeable increases in losses if pesticides were no longer available.

Diseases, Fungicides, Nematicides, and Losses

Phytophthora rot ranked as the most important soybean disease in the Corn Belt States followed by cyst nematodes, pod and stem blight, brown stem rot, and brown spot (table 19). Phytophthora rot was the only disease identified by all five States; it was ranked first in Indiana, Iowa, and Ohio; second in Illinois; and seventh in Missouri.

Major soybean fungicide treatments were seed treatments for seed rots and seedling blights. Treatments of captan alone were used on 14 percent of the acreage, carboxin plus captan on 1 percent, thiram on 5 percent, carboxin alone on 3

Table 15. Ranking of soybean insect pests in the Corn Belt States 1/

Insects	Rank 2/ 3/			
	IN	MO	OH	Region
Mexican bean beetles	1	NR	1	1
Bean leaf beetles	2	1	2	2
Japanese beetles	2	NR	3	3
Seedcorn maggots	2	NR	4	4
Grasshoppers	2	NR	5	5
Green cloverworms	2	NR	5	5
Spider mites	2	NR	5	5
Potato leaf hoppers	2	NR	5	5
Cutworms	2	NR	5	5
Wireworms	2	NR	5	5
White grubs	2	NR	NR	11
Slugs	NR	NR	5	12
Corn earworms	NR	2	NR	13

NR = Not reported.

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.

2/ In most years, insects have not been a problem for soybeans in Iowa or Illinois.

3/ 1 = Most important, 2 = second-most important, etc. Regional rankings were weighted averages of State-level rankings. State-level rankings were uniformly standardized so each would have the same mean and variance. The standardized variables were weighted by planted acres to construct the regional ordering.

Table 16. Soybean insecticide use by timing and target pest in the Corn Belt States 1/

Active ingredients	Timing 2/	Target pest	Percentage of planted acres 3/		
			MO	OH	Region 4/
				Percent	
Acephate	8,10	Corn earworms	<1	-	<1
Carbaryl	8	Beanleaf beetles	-	<1	<1
	8, 10	Corn earworms	<1	-	<1
	8	Mexican bean beetles	-	14	2
		Total	<1	14	2
Chlorpyrifos	8, 10	Corn earworms	<1	-	<1
Diazinon	ST	Seedcorn maggots and wireworms	-	<1	<1
Lindane	ST	do.	-	<1	<1
Dimethoate	8	Mexican bean beetles, Japanese beetles, and mites	-	<1	<1
Fenvalerate	8,10	Beanleaf beetles	<1	-	<1
	8,10	Corn earworms	<1	-	<1
		Total	<1	-	<1
Malathion	8	Mexican bean and beanleaf beetles	-	1	<1
Methomyl	8,10	Corn earworms	<1	-	<1
Methyl parathion	8,10	do.	3	-	<1
Toxaphene	8,10	Beanleaf beetles	<1	-	<1

- = Insignificant acreage.

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.

2/ Timing of application where:
ST = Seed treatment.
8 = Postemergence foliar or over row.
10 = Postemergence aerial.

3/ Indiana did not provide estimates of acres treated. In most recent years, insects have not been a problem for soybeans in Iowa and Illinois.

4/ State estimates were weighted by planted acres and averaged to obtain regional estimates.

Table 17. Nonpesticide soybean insect management in the Corn Belt States 1/

Insects	Insect management practice	Percentage of planted acres: OH 2/
		Percent
Beanleaf beetles	Scouting 3/	1
Japanese beetles	do.	1
Mexican bean beetles	do.	50

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ Indiana and Missouri provided no estimates. In most years, insects are not a problem for soybeans in Iowa and Illinois.
3/ Scouting is a pest detection practice which may lead to the use of pesticide or nonpesticide pest management practices.

Table 18. Average percentage soybean insect yield losses in the Corn Belt States 1/

Insects and insect control practices	Average percentage yield loss 2/ 3/		
	MO	OH	Region 4/
		Percent	
Beanleaf beetles:			
Current controls	0.1	0.2	<0.1
No pesticide controls	.3	.6	.1
Corn earworms:			
Current controls	.2	-	.1
No pesticide controls	1.2	-	.3
Japanese beetles:			
Current controls	-	.1	.1
No pesticide controls	-	.2	.1
Mexican bean beetles:			
Current controls	-	.4	.1
No chemical controls	-	7.8	1.1
Mites:			
Current controls	-	.1	.1
No pesticide controls	-	.1	.1
Seedcorn maggots:			
Current controls	-	.2	.1
No chemical controls	-	.2	.1

- = Insignificant yield loss.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ These estimates were averaged over planted soybean acres in each State. Estimates are losses from a yield where the pest causes no perceptible damage.
3/ Indiana did not estimate yield losses. In most years, insects were not a problem for soybeans in Iowa and Illinois.
4/ State estimates were weighted by harvested acres and averaged to obtain regional estimates.

percent, metalaxyl on 2 percent, carboxin plus thiram on 5 percent, and maneb on less than 1 percent (table 20). Seed rots and seedling blights caused 2.4-percent losses, but without fungicides these losses would increase to 3.4 percent (table 22). A very small acreage was treated for foliar diseases; the fungicides used were benomyl, maneb, and thiophanate-methyl. Current damage from foliar diseases was estimated to be 0.3 percent and would increase to 0.5 percent without fungicides. There was also a very small acreage treated with nematicides; losses were 1.7 percent, and would increase to 2.4 percent without nematicides.

A variety of nonchemical disease management practices were identified for soybeans (table 21). Rotations were the most commonly identified nonpesticide control practice, and were recommended by one or more States for 13 of the

Table 19. Ranking of soybean disease and nematode pests in the Corn Belt States 1/

Diseases and nematodes	Rank 2/					
	IL	IN	IA	MO	OH	Region
Phytophthora rot	2	1	1	7	1	1
Cyst nematodes	1	10	3	3	NR	2
Pod and stem blight	5	4	4	2	NR	3
Brown stem rot	6	5	1	NR	5	4
Brown spot	3	3	8	NR	NR	5
Seed rots and seedling blights	4	NR	2	NR	NR	6
Charcoal rot	6	5	NR	1	NR	7
Rhizoctonia root rot	NR	2	NR	6	2	8
Phythium	4	NR	NR	5	7	9
Viruses	8	6	5	NR	NR	10
Anthracnose	7	NR	9	4	NR	11
Downy mildew	NR	7	6	NR	NR	12
Stem canker	6	NR	9	NR	6	13
Bacterial diseases	NR	9	7	8	NR	14
Sclerotinia stem rot	NR	8	NR	NR	3	15
Phomopsis	NR	NR	NR	NR	4	16
Powdery mildew	NR	NR	9	NR	NR	17
Lance nematodes	NR	11	NR	NR	NR	18
Root lesion nematodes	NR	12	NR	NR	NR	19
Root-knot nematodes	NR	13	NR	NR	NR	20

NR = Not reported.

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.

2/ 1 = Most serious, 2 = second-most serious, etc. Regional rankings were weighted averages of State-level rankings. State-level rankings were uniformly standardized so that each would have the same mean and variance. The standardized variables were weighted by planted acres to consturct the regional ordering.

16 reported diseases and nematodes. Resistant and tolerant varieties were also commonly identified for brown stem rot, cyst nematodes, root-knot nematodes, and phytophthora root rot.

Weeds, Herbicides, and Losses

Giant foxtail, velvetleaf, pigweed, cocklebur, and lambsquarters ranked as the five most important soybean weed pests in the Corn Belt (table 23). Giant foxtail received the highest ranking in all five States. Pigweeds also ranked the highest in Missouri and Ohio, while yellow foxtail received this ranking in Iowa. Annual morningglory, green foxtail, and water hemp ranked the highest in Missouri. Giant foxtail, velvetleaf, pigweed, and cocklebur were the only weeds to be identified by all five States.

The three most widely used soybean herbicides included metribuzin on an estimated 49 percent of the acreage, trifluralin on 44 percent, and alachlor on 35 percent, applied individually and in tank mixes (table 24). Other major soybean herbicides

Table 20. Soybean fungicide and nematicide use in the Corn Belt States 1/

Active ingredients	Timing 2/	Target pest	Percentage of planted acres 3/					
			IL	IN	IA	MO	OH	Region
			Percent					
Captan	ST	Seed rots and seedling blights	15	10	10	25	10	14
Carboxin	ST	do.	<1	20	-	-	-	3
Carboxin + captan	ST	do.	3	-	-	-	30	1
Carboxin + thiram	ST	do.	-	-	5	-	-	1
Maneb	ST	do.	-	4	-	-	-	<1
Metalaxyl	ST	do.	-	1	5	-	6	2
Thiram	ST	do.	3	-	-	25	1	5
Benomyl	3,6	Foliar diseases	3	-	-	-	1	1
Maneb	6	do.	-	1	-	-	-	<1
Thiophanate-methyl	6	do.	-	1	-	-	-	<1
Aldicarb	1,2	Cyst nematodes	1	1	<1	-	-	<1
Carbofuran	2	do.	-	1	<1	-	-	<1
Fenamiphos	2	do.	-	1	-	-	-	<1
Terbufos	2	do.	-	1	-	-	-	<1

- = Insignificant acreage.

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.

2/ Timing of application, where: ST = Seed treatment, 1 = preplant, 2 = in furrow at planting, 3 = early pod set and 14 days later, 6 = late flowering to early pod set and 2-3 weeks later.

3/ State estimates were weighted by planted acres and averaged to obtain regional estimates.

Table 21. Nonpesticide soybean disease and nematode management in the Corn Belt States 1/

Diseases and nematodes	Disease/nematode management practices	Percentage of planted acres				
		IL	IN	IA	MO	OH
		Percent				
Anthracnose leaf blight	Rotate to corn	25	-	-	-	-
Brown spot	Rotate to corn	25	-	-	-	-
Brown stem rot	Resistant varieties	1	-	-	-	-
	Rotate to corn	25	15	60	-	-
Bud blights	Do not plant near alfalfa	-	-	2	-	-
Charcoal root rot	Rotate to corn	-	15	-	15	-
Nematodes:						
Cyst	Balanced fertility	3	-	-	-	-
	Resistant varieties	8	5	-	22-23	-
	Rotate to corn	25	25	2-3	-	-
Lesion	Rotate to corn	-	25	-	-	-
Root-knot	Resistant varieties	-	2	-	-	-
	Rotate to corn	-	25	-	-	-
Phomopsis	Late planting	-	-	-	-	2
	Rotate to corn	-	-	-	-	2
Phytopthora root rot	Improved drainage	1	-	-	-	-
	Plowing	-	10	-	-	-
	Resistant varieties	8	50	-	90	10
	Rotate to corn	-	20	-	-	-
	Tolerant varieties	-	-	-	-	50
Pod and stem blight	Rotate to corn	25	-	-	-	-
Rhizoctonia	Late planting	-	2	-	-	-
	Rotate to corn	-	5	-	-	-
Seed rots and seedling blights	Certified seed	95	-	-	-	-
	Late planting	-	10	10	-	-
	Tile drainage	1	-	-	-	-
Stem canker	Rotate to corn	25	-	-	-	-
Viruses	Certified seed	95	-	5	-	-
All diseases	Resistant varieties	-	-	50	-	-
	Rotate to corn	-	10	-	-	-
	Scouting 2/	50	-	<1	-	-

- = Insignificant acreage.

1/ Corn and Soybean Commidity Assessment, NAPIAP, USDA.

2/ Scouting is pest detection practice which may lead to the use of pesticide or nonpesticide management practices.

Table 22. Average percentage soybean yield losses from diseases and nematodes controlled with pesticides in the Corn Belt States 1/

Pests and pest	Average percentage yield loss 2/					
	IL	IN	IA	MO	OH	Region 3/
	Percent					
Seed rots and seedling blights:						
Current controls	0.1	0.2	2.8	0.4	12.4	2.4
No pesticide controls	.8	2.4	3.1	1.5	14.8	3.4
Foliar diseases:						
Current controls	.2	1.9	-	-	.1	.3
No pesticide controls	.5	2.2	-	-	.2	.5
Nematodes (soybean cyst nematodes):						
Current controls	1.7	8.9	-	-	-	1.7
No pesticide controls	1.7	14.0	-	-	-	2.4

- = Insignificant yield losses.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ These estimates were averaged over the entire planted acreage in the State. Estimates are losses from yields where the pest causes no perceptible damage.
3/ State estimates were weighted by planted acres and averaged to obtain regional estimates.

included metolachlor, used on 14 percent of the acreage, linuron on 13 percent, and chloramben on 12 percent. These six herbicides were often mixed with each other, such as alachlor plus linuron on 7 percent of the acreage, alachlor plus metribuzin on 11 percent, metolachlor plus metribuzin on 5 percent, and metribuzin plus trifluralin on 20 percent. Fluchloralin, glyphosate, naptalam, paraquat, and pendimethalin were used on a relatively small acreage; each was applied to approximately 2 percent of the soybean acreage. The major postemergence herbicide was bentazon, applied to 20 percent of the acreage, while acifluorfen and 2,4-DB were each applied to 2 percent. Bentazon was often applied in sequence with alachlor, metolachlor, trifluralin, or mixes including these materials.

There was wide variability among State weed management practices and acreage estimates (table 25). Missouri reported burning, cultivating, or mowing 80 percent of the acreage. Illinois reported crop rotation, double cropping, narrow rows, and rotary hoeing. Iowa reported crop rotation, cultivation, narrow rows, and rotary hoeing. Scouting was reported by Iowa, Illinois, and Ohio.

Weeds caused a 7.5-percent loss to soybeans in the Corn Belt States (table 26). If bentazon were no longer available, losses would increase to approximately 12 percent. If metribuzin were no longer available, losses would increase to 8 percent. Losses would increase to 12 percent if either the dinitroanilines

Table 23. Ranking of soybean weed pests in the Corn Belt States 1/

Weeds	Rank 2/					
	IL	IN	IA	MO	OH	Region
Giant foxtail	1	1	1	1	1	1
Velvetleaf	2	3	2	2	5	2
Pigweed	3	8	3	1	1	3
Cocklebur	2	2	6	2	6	4
Lambsquarters	4	10	4	NR	6	5
Pennsylvania smartweed	3	NR	5	2	4	6
Yellow foxtail	6	NR	1	NR	NR	7
Jimsonweed	2	5	NR	NR	7	8
Annual morningglory	2	7	NR	1	10	9
Shattercane	5	13	8	NR	NR	10
Black nightshade	NR	11	7	4	8	11
Giant ragweed	7	6	NR	NR	1	12
Volunteer corn	NR	NR	5	NR	12	13
Climbing milkweed	NR	9	8	2	NR	14
Quackgrass	7	9	8	NR	NR	15
Common ragweed	4	NR	NR	NR	9	16
Johnsongrass	7	4	NR	NR	NR	17
Yellow nutsedge	5	NR	NR	3	11	18
Green foxtail	NR	NR	NR	1	2	19
Canada thistle	NR	14	8	NR	NR	20
Fall panicum	6	12	NR	NR	NR	21
Hemp dogbane	NR	NR	8	NR	NR	22
Wooly cupgrass	NR	NR	8	NR	NR	23
Sunflower	NR	NR	9	4	NR	24
Bur cucumber	NR	NR	NR	NR	3	25
Bindweed	NR	9	NR	6	NR	26
Water hemp	NR	NR	NR	1	NR	27
Common milkweed	NR	NR	NR	2	NR	28
Horsenettle	NR	NR	NR	5	NR	29
Swamp smartweed	NR	NR	NR	6	NR	30

NR = Not reported.

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.

2/ 1 = Most serious, 2 = second-most serious, etc. Regional rankings were weighted averages of State-level rankings. State-level rankings were uniformly standardized so that each would have the same mean and variance. The standardized variables were weighted by planted acres to construct the regional ordering.

or the acetanilides were no longer available, and to about 10 percent if no triazines were available. The increase in losses would be insignificant if acifluorfen, glyphosate, linuron, naptalam, paraquat, or 2,4-DB were no longer available. Good alternatives were available for linuron, while the others were used on an insignificant acreage. If no herbicides were available, losses

Table 24. Soybean herbicide use in the Corn Belt States 1/

Active ingredients	Percentage of planted acres					
	IL	IN	IA	MO	OH	Region 2/
	Percent					
Acifluorfen	-	-	-	9	4	2
Alachlor	8	3	11	28	15	13
Bentazon	17	65	9	16	9	20
Bifenox	1	-	-	-	-	<1
Chloramben	9	-	9	10	17	9
Diclofop-methyl	-	-	1	-	-	<1
Fluazifop-butyl	-	-	-	1	-	<1
Fluchloralin	4	-	2	-	-	2
Glyphosate	-	-	4	3	-	1
Linuron	-	-	-	19	5	4
Metolachlor	4	2	4	28	7	8
Metribuzin	1	-	-	49	14	11
Naptalam	2	4	-	6	-	2
Paraquat	-	-	-	5	2	1
Pendimethalin	-	-	2	2	2	1
Sethoxydim	-	-	-	1	-	<1
Trifluralin	18	6	29	46	4	22
2,4-DB	-	-	-	16	-	3
Alachlor + bifenox	-	-	2	-	-	<1
Alachlor + chloramben	1	-	5	-	-	2
Alachlor + chlorpropham	-	-	1	-	-	<1
Alachlor + linuron	7	15	6	-	14	7
Alachlor + metribuzin	7	26	12	-	18	11
Bifenox + trifluralin	-	-	1	-	-	<1
Chloramben + metolachlor	-	-	2	-	-	<1
Chloramben + pendimethalin	-	-	1	-	-	<1
Chlorpropham + trifluralin	-	-	1	-	-	<1
Fluchloralin + metribuzin	-	-	2	-	-	<1
Metolachlor + linuron	-	-	2	-	8	<1
Metolachlor + metribuzin	5	14	2	-	12	5
Metribuzin + pendimethalin	2	-	2	-	-	1
Metribuzin + trifluralin	33	19	30	-	-	20
Trifluralin + chloramben	2	-	-	-	-	<1
Trifluralin + linuron	-	16	-	-	-	<1
Trifluralin + vernolate	-	1	1	-	-	<1
Alachlor + linuron + glyphosate	-	<1	-	-	-	<1
Alachlor + linuron + paraquat	-	<1	-	-	-	<1
Alachlor + metribuzin + glyphosate	-	<1	-	-	-	<1
Alachlor + metribuzin + paraquat	-	<1	-	-	-	<1
Chloramben + trifluralin + vernolate	-	-	2	-	-	<1
Linuron + oryzalin + paraquat	-	<1	-	-	-	<1

- = Insignificant acreage.

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.

2/ State estimates were weighted by planted acres and averaged to obtain regional estimates.

Table 25. Nonpesticide soybean weed management in the Corn Belt States 1/

Nonpesticide weed control practices	Percentage of planted acres				
	IL	IN	IA	MO	OH
	Percent				
Burning wheat stubble, cultivation, or mowing	NR	NR	NR	80	NR
Crop rotation	90	NR	95	NR	NR
Cultivation	70	NR	97	80	NR
Double cropping	4	NR	NR	NR	NR
Narrow rows	20	NR	5	NR	15
Rotary hoe	39	NR	52	NR	NR
Scouting 2/	35	NR	5	NR	1

NR = Not reported.
1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ Scouting is a pest detection practice which may lead to the use of pesticide or nonpesticide pest management practices.

would be much greater, and would increase to about 39 percent with extra cultivation and to about 56 percent with current cultivation.

RESEARCH AND DATA NEEDS

The field corn and soybean pesticide assessment reveals several important research and data needs. First, State and Federal pesticide use surveys should continue in order to provide current information. The surveys should identify the major target pests for pesticide treatments. These surveys need to identify the relative importance of nonpesticide pest management practices. There are wide variations in the practices identified and the estimates of use between States. Therefore, State pest control experts should develop standardized definitions of practices to be included in survey questionnaires.

Second, there should be more empirical field research concerning pest damage to crop yield and quality because satisfactory baseline data do not exist for many economic analyses. Existing projects which estimate pest damage under various circumstances should be expanded to include how pests interact to damage crops and how additional factors such as climate influence crop damage and quality. Research should also estimate the extent of various degrees of yield and quality damage.

These needs might be accomplished by sampling farmers' fields over a number of years to estimate pest infestations and their effect on yield and quality. With such studies, researchers could project the likelihood of various degrees of pest damage. Such research would provide a stronger basis for estimating the economic effects of potential regulatory actions and the production effects of new and improving technologies.

Table 26. Average percentage soybean weed yield losses in the Corn Belt States 1/

Weed control practices	Average percentage yield loss 2/					
	IL	IN	IA	MO	OH	Region 3/
	Percent					
Current controls 4/	6.6	12.3	5.5	9.8	4.8	7.5
Remove: 5/						
Acifluorfen	6.7	12.3	5.5	9.8	5.1	7.5
Alachlor	6.6	12.3	5.5	9.8	5.5	7.5
Bentazon	11.2	24.7	10.0	9.8	6.7	12.0
Chloramben	6.6	12.3	5.5	9.8	4.8	7.5
Glyphosate	6.6	12.3	5.5	9.8	4.8	7.5
Linuron	6.6	12.3	5.5	9.8	5.9	7.6
Metolachlor	6.6	12.3	5.5	9.8	5.5	7.5
Metribuzin	6.6	14.4	5.5	9.8	7.0	8.0
Naptalam	6.8	12.3	5.5	9.8	4.8	7.5
Paraquat	6.6	12.3	5.5	9.8	4.8	7.5
Pendimethalin	6.6	12.3	5.5	9.8	4.8	7.5
Trifluralin	6.6	12.3	5.5	9.8	5.2	7.5
2,4-DB	7.3	12.3	5.5	9.8	4.8	7.7
Acetanilides	8.1	15.8	16.9	9.8	9.9	11.9
Dinitroanalines	8.2	16.1	19.0	9.8	5.3	12.0
Diphenyl ethers	6.6	12.3	5.5	9.8	4.8	7.5
Substituted ureas	7.4	12.3	5.5	9.8	5.9	7.8
Thiocarbamates	6.7	12.3	5.5	9.8	4.8	7.5
Triazines	8.2	12.3	13.1	9.8	7.0	10.2
No chemical controls:						
With extra cultivation	47.4	72.7	31.6	32.5	8.0	39.4
With current cultivation	64.9	100.0	39.0	50.0	29.3	56.1

1/ Corn and Soybean Commodity Assessment, NAPIAP, USDA.
2/ These estimates were average yield losses over the entire planted acreage in the State from a maximum where weeds cause no perceptible loss. Other pest problems and farm management practices were held constant.
3/ State estimates were weighted by planted acres and averaged to obtain regional estimates.
4/ These estimates assume the current pattern of weed control practices in each State.
5/ These estimates assume that only the specific herbicide or herbicide group is no longer available for use. Other herbicides or control practices were substituted, and all other pest problems and farm management practices were held constant.

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